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ABSTRACT

Any explanation of the absence of African Americans from the workforce in positions requiring mathematics usually begins with an acknowledgment of black underachievement in mathematics from the early grades and continuing throughout secondary schooling. Yet there are those among this group that are successful in studying mathematics. This paper discusses school factors associated with successful African American study of secondary college-preparatory mathematics. It explores the hypothesis that specific school factors, alone or in combination with individual, family, and classroom factors--some manifest as early as eighth grade--may serve as predictors of continued college-preparatory mathematics coursetaking by African American secondary students. The subject pool came from the National Education Longitudinal Study. A base year core of 24,599 African American students was selected, and these students were surveyed in 8th and 10th grades. Findings suggest that a 10th grade African American doing well in the appropriate level college preparatory mathematics class more than likely would have attended an eighth-grade public school in a nonrural part of the Northeastern North Central part of the United States. That school had an honor society, had high homework expectations of its students, and the students themselves placed a high priority on learning. The school also had a small student body, a smaller proportion of students eligible for free lunch, a larger proportion of minority students, and a smaller eighth-grade enrollment (less than 200). (Contains 3 tables and 44 references.) (SLD)

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UD032424

School Factors Associated with African American Students Who Thrive in College-Preparatory Mathematics

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Though increasingly needed in the U.S. workforce in technological and scientific positions requiring mathematics, African Americans are significantly underrepresented. Any explanation of their absence usually begins with an acknowledgment of Black underachievement in mathematics from the early grades and continuing throughout secondary schooling. Yet there are those among this group that are successful in studying mathematics. This paper discusses school factors associated with successful African American study of secondary college-preparatory mathematics. It explores the hypothesis that specific school factors—alone or in combination with individual, family, and classroom factors—some manifest as early as eighth grade, may serve as predictors of continued college-preparatory mathematics coursetaking by African American secondary students.

Differential student learning in mathematics by race in the United States has been widely documented (Anick, Carpenter, & Smith, 1981b; Berryman, 1983; Patterson, 1991). Even as early as fourth grade, the performance of Black students can be shown to lag behind that of Asians and Whites on national surveys of mathematics achievement (Jones, 1984; Jones, 1987; Jones, Burton, & Davenport, 1984; Kohr, Coldiron, Skiffington, Masters, & Blust, 1987). School- and classroom-related factors such as mathematics course selection choices and mathematics learning opportunities are among the prominent explanations for this differential.

A review of the literature related to the mathematics performance of American students reveals little evidence that successful African American mathematics students exist. Indeed, one writer noted that "the literature on minorities and mathematics achievement can be seen as falling into three categories: studies that describe and document underachievement in mathematics by minorities, studies that predict that underachievement ..., and studies that, at least tacitly, make causal links between minority group membership and that underachievement..."(Secada, 1992). It is important to recognize that an investigation's findings are limited by what was deemed worthy of exploration at the outset—not only what will be examined, but what will be ignored as well.

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This study investigated the school factors associated with successful African American study of secondary college-preparatory mathematics. It tested the hypothesis that identifiable factors of the specific school the student attended in the eighth grade—alone or in combination—may serve as predictors of continued college-preparatory mathematics coursetaking by African American secondary students.

Background

Large numbers of Black students do not meet the necessary requirements for a four-year college or university. Even those that do so generally choose to take exactly the minimum amount of high school mathematics. Rarer still are those who continue to study mathematics at the undergraduate level beyond general education requirements, resulting in only a meager number of African American mathematics, science, or engineering majors at the end of the pipeline (Fullilove & Treisman, 1990).

The differential effectiveness of schooling literature is extremely fertile with suggestions for interesting constructs that might explain the absence of Black mathematicians at the end of the scientific and technological pipeline. A few of these include studies that have: (1) linked differential effectiveness of schooling to social class, race, gender, and other demographic conditions (Kozol, 1991; Powell, Farrar, & Cohen, 1985; Reyes & Stanic, 1988; Stanic, 1991; White, 1982); (2) suggested a connection between differential learning outcomes and unequal distribution of learning opportunities (Miller & Linn, 1989; Oakes, 1985; Ogbu, 1978); (3) investigated the comparative impact of peer influences (Fordham, 1988; Fordham & Ogbu, 1986), and (4) looked at school effectiveness characteristics that are related to student progress (Brophy, 1990; Engman, 1989). However, most of these were singly-focused studies that did not investigate possible interactions between factors nor attempt to discover how Black mathematics success is produced or differs from Black mathematics failure.

Yet in spite of this dire reality, there does exist—though comparatively small—a group of African American students who continue to thrive in their secondary mathematics study. This study investigated the factors associated with the persistence and evident success in overcoming the odds that these students exemplify.

Purpose

Though the gap between White and Black mathematics achievement has been documented (Anick, Carpenter, & Smith, 1981; Berryman, 1983; Patterson, 1991), there is yet no firm grasp of which factors separate African American secondary students who thrive while studying college-preparatory mathematics from those that do not. If we accept the assertion that the mathematical pool from which all successful quantitative graduate students derive is essentially formed by the conclusion of high school (Berryman, 1983), it becomes increasingly important to investigate what transpires during this critical period.

Understanding the interplay of factors that nourish the requisite achievement for sustained college-preparatory mathematics coursetaking can provide policymakers with practical directions for improving the perseverance of Black high school students in mathematics at its most propitious schooling moment. To that end, this study expressly raises the following question: Are there factors associated with the eighth-grade schools that African American students attend that can serve as predictors of continued college-preparatory mathematics coursetaking through grade ten?

Empirical and Theoretical Context

The empirical and theoretical underpinnings of this work stretch all the way back to Coleman's 1966 work, *Equality of Educational Opportunity*, which launched the modern era of research into differential effectiveness of schooling (Coleman, Campbell, Hobson, McPartland, Mood, Weinfeld, et al., 1966). Though expecting to find otherwise, his findings—though later widely challenged—suggested almost no relationship between measures of school quality and student

outcomes. The debate that followed this pivotal work continues today as investigators try to discover links between characteristics of schools and student performance.

This study examined eight school factors as possible predictors for continued mathematics college-prep coursetaking in tenth grade. They were academic press and seven school demographic characteristics. Each one had previously been explored as a contributor to student success and builds upon the work of the researchers listed: (1) academic press (Pifer, 1994), (Engman, 1989), (Winfield, 1991), (Oakes, 1989), (Thornton & Eckland, 1980), (Useem, 1990); (2) low-income and minority enrollments (Oakes, 1990); (3) urbanicity/school SES (Anick, et al., 1981; Mullis, et al., 1991), (Oakes 1990), (Thornton & Eckland, 1980), (Kohr, et al., 1987; Kohr, Masters, Coldiron, Blust, & Skiffington, 1991), (Robitaille & Garden, 1989); (4) school geographic location (Mullis, et al., 1991); (5) school type (Coleman, Hoffer, & Kilgore, 1982), (Mullis, et al., 1991); (6) percent minority enrollment (Wells & Crain, 1994), (Fordham & Ogbu, 1986), (McCandless, 1990), (Fordham, 1988; Ogbu, 1988; Ogbu & Matute-Bianchi, 1986); (7) school grade span (Catterall, 1995); and (8) school size (Finn, 1989), (Secada, 1992).

Making the distinction between successful and unsuccessful mathematics students has been complicated by the fact that it has not been determined as yet that identical factors operate between successful and unsuccessful African American students in the same manner and direction, or to the same degree as they do in the non-minority population (Willig, Harnisch, Hill, & Maehr, 1983). That is to say, for each distinct demographic condition (*e.g.*, SES or gender), there can be no assurance without explicit investigation that the given dependent variable (*i.e.*, mathematics persistence) will react upon African American students in the same way that it does upon white or Asian students.

Moreover, any productive discussion of this problem requires a common definition of mathematics success. For some, successful mathematics study is represented by achievement as indicated by the teacher-assigned grades in mathematics courses. But to others, mathematics success is defined by superior mathematics performance as demonstrated by a score on a

designated assessment instrument. Any progress in our quest to discover the difference between mathematically successful and unsuccessful students must begin with a resolution of the problems associated with these two different definitions. If we accept the former definition, besides the obvious variance expected between both schools with different academic climates (Thornton & Eckland, 1980) and teachers with individual grading policies (Olson, 1989), we must confront the problem of students who have achieved superior marks but still perform poorly on standardized tests and are thereby disadvantaged in academic situations that use such assessments as the ticket to further mathematics learning opportunities (Griffin, 1990). Whereas, adopting the latter definition of mathematics success, necessitates ignoring the contribution superior achievement within one's own classroom and school—no matter how limited its actual challenge—makes to the motivation, intent, work habits, and self-efficacy that shape the subsequent drive to study mathematics.

Previous research (Griffin, 1990; Horn & Walberg, 1984; Mullis, et al., 1991; Mullis, et al., 1990; Welch, Anderson, & Harris, 1982) has suggested a connection between persistence in coursetaking and mathematics achievement. This work seems to suggest that one way to assure an increase in mathematics performance is to maintain student enrollment in sequential college-preparatory mathematics courses throughout high school.

Some reports have suggested that mathematics achievement is quite sensitive to additional coursetaking(Rock, et al., 1986). As a result, when some schools added more mathematics requirements they expected improved student mathematics performance. Unfortunately, Patterson's findings revealed that, in terms of general curriculum content, curriculum content for low-achieving students, and how teachers and schools adapted to increased competency test demands, new courses had primarily low-level content even though schools had increased the number of mathematics and science courses (Patterson, 1991).

Clearly, then, this leads the discussion to the explicit findings that achievement is a function not only of the number, but also the level of courses taken. To assess the dependence of high school

mathematics learning on both the amount and level of coursework as well as other productive factors, the achievement and interest scores of a NAEP sample of 1480 seventeen-year-olds were regressed on each other and 14 other variables. With the variables controlled for one another, achievement appears to depend not only on the number but also the level of the courses, as well as traditional teaching method, television viewing, home environment, SES, sex, and ethnicity. Similarly, interest was associated with student-centered and stimulating teaching, home environment, and homework. Students who took more advanced courses in mathematics rated their teachers more favorably, did more homework, and had more highly educated parents. (Horn & Walberg, 1984). In light of the foregoing discussion, this study uses persistence in taking secondary college-preparatory mathematics courses as its focus to distinguish between the group of Black students who are most likely to achieve mathematically during high school from those that will not.

Methodology

Subjects. The subject pool for this study was formed by selecting students from the National Education Longitudinal Study (NELS:88) that met the following criteria: (1) subjects were included in both the 1988 and 1990 cycles (*i.e.*, "freshened students" were excluded[1]); (2) they were identified as African American in the base year survey (by self and/or parent) by classifying themselves for the purposes of the survey as "Black, not of Hispanic origin;" and (3) they attended a school in which at least 75 per cent of the mathematics teachers of eligible African American participants completed questionnaires. Using a two-stage stratified sample, the base year core of 24,599 eighth grade students was selected from a nationally representative sample of 1,052 schools. Students were surveyed in both eighth and tenth grades. Their parents, mathematics teachers, and school administrators were questioned in grade eight and their current mathematics teachers and school administrators were again surveyed in grade ten. The subject

[1] The NELS protocol called participating students in the base year "core" students. The core student sample was then augmented through a process called "freshening," the aim of which was to provide a representative sample of students for each cycle by replacing students who had left the study in the interim with new ones at that grade level.

pool consisted of the subsample of all African Americans for whom there was adequate data available from their eighth grade school personnel (N = 1422).

The subjects were not evenly distributed geographically. When compared to that of the original NELS sample, this subject pool resided much more in the South and was much less represented in the West. Table 1 delineates these differences.

Table 1 Geographic Distribution of Students

Location	NELS:88 (N=24,599)	(N=1422)
Northeast	4933 (19.2%)	256 (18.0%)
North Central	6127 (25.7%)	252 (17.7%)
South	8462 (35.4%)	813 (57.2%)
West	5040 (19.7%)	101 (7.1%)

Procedures. Eight factors measured across two time periods hypothesized to be associated with ongoing academic success were operationalized by questionnaire items on the student, parent, teacher, and school administrator questionnaires in the NELS:88 database. The NELS:90 and NELS:92 databases provided the items as well as relevant transcript information required to follow the original cohort through tenth grade.

Dependent variable. The process for deriving the dependent variable—persisting in studying college-preparatory mathematics—is complicated by the fact that the question: "What mathematics course is [the student] taking now?" was not asked of any First Follow-up participants. Although the 1990 mathematics teacher was asked the title of the mathematics course in which the targeted student was enrolled, that information was not coded. Moreover, only algebra and geometry classes were specifically identified on the teacher questionnaire.

Consequently, the transcript data was used in the following manner to make an assignment of persisting (or not) in tenth grade. First, transcripts were searched to identify which students were taking a college-preparatory mathematics course during grade ten. If the transcript identified more than one mathematics course, all were removed except one. These removal decisions were made based—when all other things were equal—upon (1) the course title (lower level courses were removed), (2) the term in which the course was taken (year-long courses were maintained over shorter term courses, (3) regular term courses prevailed over summer school courses, and (4) the grade received in the course (the course in which lower grades were awarded were removed). Second, the courses were matched to the students by student identification number. Finally, if (a) the course was equivalent to geometry or higher, including integrated mathematics courses such as those found in the state of New York and (b) the grade was 'C-' or better, the student was determined to be "persisting." All other students, including those for whom no mathematics course was recorded in tenth grade, were designated as "not persisting." The name given this dependent variable was THRIVE.

To discover the school characteristics of the THRIVErs, frequencies for all variables were obtained for those who were designated as THRIVErs. To determine whether significant distinctions could be drawn between successful and unsuccessful students on the basis of the individual or composite factors suggested by the model, comparative analyses were done examining frequencies of the two groups as well as using chi-square analysis on the single factors with the dependent variable, THRIVE. Finally, to assess whether the hypothetical model had predictive power, a logistic regression model was used to explore the relationship between THRIVE and a set of predictors. The goal was to determine whether thriving, as an event, would or would not occur under certain conditions, as well as to identify which variables might be useful in making the prediction.

Results

The study found that only 9.1% of the students were receiving a 'C-' or better in a level of tenth grade college-preparatory mathematics that would allow them to attend a four-year college or

university upon graduation from high school (*i.e.*, the THRIVErs). The results of chi-square analysis produced nine measures on which THRIVErs and non-THRIVErs differed in a statistically significant way ($p \leq 0.05$) on eighth-grade school measures. They are: (1) availability of an honor society [a] (2) students place a high priority on learning[b], (3) students face competition for grades [c], (4) geographical region, (5) type of school, (6) whether the school was exclusively a junior/middle school or not, (7) the proportion of the students eligible for free or reduced-price lunch, (8) total school enrollment size, and (9) size of eighth grade enrollment.

Table 2 Significant Chi-square Results for THRIVErs and Non-THRIVErs

School Variables	χ^2	*df*	*p*
Academic Press 1[a]	8.5381	1	.0035
Academic Press 2[b]	22.1687	4	.0002
Academic Press 3[c]	49.7292	4	.0000
Geographic Region	11.9341	3	.0076
Type of School	46.3221	3	.0000
Grade Span in School	21.2479	1	.0000
Percent Free Lunch	50.8571	7	.0000
Total School Enrollment	25.4258	6	.0003
Eighth Grade Enrollment	65.8415	5	.0000

Of the school factors that were contributors to the model, only three demographic predictors were found significant—geographical region, type of school, and eighth grade enrollment size. First, using schools in the South as the reference (G8REGON), students from schools in the North Central region and in the Northeast were found to be 2.9 and 2.5 times, respectively, as likely to be succeeding in tenth grade college-prep mathematics as those in the South. No

difference was found between schools in the West and in the South regarding the possibility of thriving in tenth grade. Second, African American students in Catholic schools had a lower possibility of thriving when compared to the other types of schools (G8CTRL) represented in this study. Specifically, they had only a 47% chance of being successfully enrolled in a tenth grade college-preparatory mathematics course when compared to public school students. The students in other religious and non-religious private schools were not significantly different from students in public schools regarding their probabilities of thriving. Finally, compared with schools with large eighth grade enrollments, these findings reveal that students from schools with smaller eighth grade enrollments have a better chance of thriving in grade ten mathematics. Based upon the scale used for the variable, G8ENROL, for every one-point increase in the 8th grade enrollment composite, there was a reduced possibility of successfully completing college-prep mathematics in grade ten to 74% of the original. Since the designed scale for variable G8ENROL does not have equal intervals, the exact relationship between THRIVE and G8ENROL is not clear. However, the negative relationship is evidenced within the score range.

Table 3 Significant Relationships between THRIVE and Three Predictors in Logistic Model

Variable	Wald	*df*	Exp (B)	*p*
G8REGON	12.04	3		0.007
Northeast vs. South	7.49	1	2.53	0.006
North Central vs. South	7.63	1	2.85	0.006
West vs. South	0.23	1	0.72	0.629
G8CTRL	7.79	3		0.051
Catholic vs. Public	3.50	1	0.47	0.061
NAIS private vs. Public	1.61	1	1.93	0.205
Other private vs. Public	0.26	1	0.00	0.607
G8ENROL	9.79	1	0.74	0.002

The model did not achieve high predictability because of the highly skewed distribution of unsuccessful over successful students in the sample. According to these findings, African American students appear to fare better in: (1) North Central and Northeastern states over those in the South or West; (2) public or NAIS private schools over those in Catholic schools or other types of private schools; and (3) smaller sized enrollments over larger ones for eighth grade student bodies.

Conclusions

According to the results of this study, a tenth grade African American who is doing well in the appropriate level college-preparatory mathematics class in which she is enrolled more than likely would have attended an eighth-grade public school in a non-rural part of either the Northeast or North Central part of the United States. That school had an honor society, had high homework expectations of its students, and the students, themselves, placed a high priority on learning. Moreover, this school's small student body (less than 399) had: (1) a smaller proportion of students eligible for free/reduced-price lunch, (2) a larger proportion of minority students, and (3) a smaller eighth grade enrollment (less than 200).

Discussion

No matter how often the dire circumstances surrounding African American mathematics performance is stated, it continues to be surprising. For the majority population, conventional wisdom estimates that the half-life of the successfully achieving college-preparatory mathematics pool for each course after algebra is one year. If this assumption has any merit, then we might expect 50% of the majority group to be available to study geometry (or its equivalent course) and 25% to remain after that year. This 25% represents almost three times the proportion of THRIVErs found in this study (9.1%) in only two years .

But rather than continuously lamenting this small proportion of THRIVErs, we must instead initiate further study that focuses upon what we can learn from that nine percent. What about

their personal, family, and classroom experiences can inform our work with others who have not as yet shown such mathematical promise?

This study raises issues that are neither uncomplicated nor unimportant. The problem presented to the nation's schools by one ethnicity continuing to be disproportionally represented in its unsuccessful group is complicated because it attests to the continuous struggle to determine exactly what the function of schools ought to be in our society. Should they be sorters and pay homage to meritocracy at every turn, as the fallout from the functional theorists might urge? Or should they recognize as rampant and unnecessary society's over-credentialing and reconfigure schools to eliminate attempts to reproduce the present hierarchy of social classes as conflict theorists assert? Can a system reward merit and still provide equal opportunity? Can the ends ever justify the means? (For example, what if separate classes for African American boys showed giant increases that brought their mathematics achievement to the point where it surpassed that of Asians? Should we ever consider such practices and if implemented, how long should they last?)

And these issues are also very important. That is because what is at stake is the opportunity for a significant part of our citizenry to develop its full mathematical potential—with or without the inevitable benefits (once realized), that will amass for the entire body politic. Moreover, it is important to recognize this as a developmental task for this comparatively young nation since by so doing we chart a path that can provide the scaffolding of confidence and justice that will be needed to solve evermore threatening global problems.

Remembering that we started from the premise that results provided by the study of the general student population might not be generalizable to the population of interest, it is important to remember that the converse of that proposition may also need inspection. Though Montessori's work was developed with the specific needs of poor Italian children in mind, it has been imported successfully (with adaptation) into the general population. Likewise, in our search for ways to address the problems associated with Black mathematics underachievement, programs

with a proven record of success should be studied—whether they exemplify the established academic educational canon or not.[2] For instance, could there be some clash between home and instructional environments that has not been studied (or understood yet) that produces barriers to student achievement? Careful investigation of childrearing practices and their implications for different kinds of instructional practices may result in insights that may be generalized to other populations.

As with most other human endeavors, research must constantly address the impact of change and how the effectiveness of its work is influenced by it. Applying simplistic solutions to so complex a problem as the topic of this discussion may be much worse than sacrificing the time and patience needed to await research-supported policies that could suggest integrated approaches to address the relevant issues. On the other hand, by the time such thorough study is complete, the conditions would probably be so different that the proposed solutions might be outdated. Nevertheless, in this case it would appear that the consequences of ignoring the issues surrounding how schools produce such vast differences in schooling outcomes is so menacing to everyone's well-being as to be worthy of both forms of attack.

[2] An example would be the academies in inner-city Chicago founded and still operating by Marva Collins that produced scholars while drawing its student population from low-income housing projects that exhibited all of the negative social characteristics associated with such environments.

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